Biofilter Treatment System at the East Kingston Septage Facility

Final Project Report
of Water Quality Monitoring
1996 and 1997

Bodwell Farm, East Kingston, NH

New Hampshire Department of Environmental Services

NHDES

January 2001

NHDES-R-WD-01-2

Biofilter Treatment System at the East Kingston Septage Facility
Final Project Report of Water Quality Monitoring
1996 and 1997

Prepared by

Andrea F. Donlon
Watershed Management Bureau
January 2001

published by

New Hampshire Department of Environmental Services
6 Hazen Drive, P.O. Box 95, Concord, NH 03302-0095

Table of Contents

List of Figures

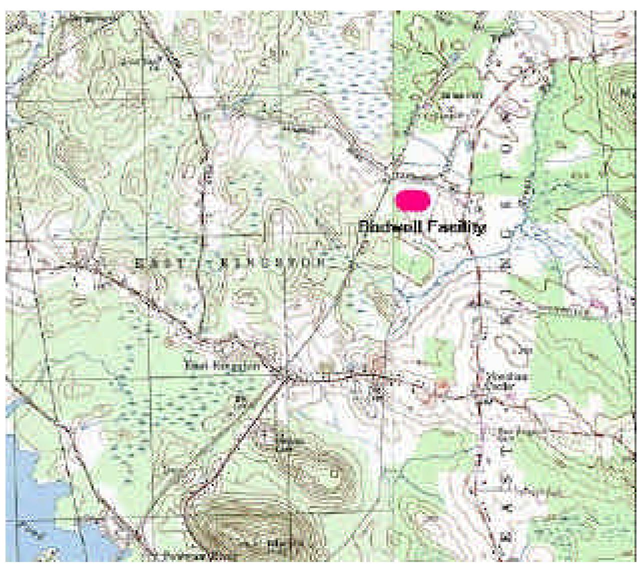
List of Tables

Project Summary

Most septage generated in New Hampshire has historically been disposed of, and treated at, municipal wastewater treatment facilities. As more homes with septic systems are developed, the need to pump septage out regularly has put an additional strain on the capacity of municipal treatment facilities, and has created a need for alternative treatment methods. Such alternatives have included septage-only facilities, lagoons, and land spreading. Septage-only treatment facilities are often expensive and unlikely to be built, and land spreading is politically controversial. This report summarizes the monitoring results for a small, private facility built to treat domestic source septage using constructed wetlands.

The Biological Recycling Company in East Kingston, New Hampshire had been receiving residential septage since approximately 1982. This facility is owned and operated by Dan Bodwell and is located on 82 acres of land near the intersection of Route 108 and Sanborn Road in East Kingston (Figure 1). Initially, discharge of septage was to a single, earthen lagoon. In 1992, after considerable research, Dan Bodwell built a small-scale trial wetland septage facility. The trial facility included two 8×20 ft wetland cells, lined with three layers of black plastic and planted with cattails and reed canary grass, and a small, unlined receiving pond. Approximately 1,000 gallons per day (gpd) of septage was diverted from the lagoons into the wetlands. The trial system proved capable of removing pollutants, primarily nitrates, and was operable during winter without freezing and without plant damage. This pilot plant operated for three or four years.

Figure 1. Locus map of Bodwell Septage Facility, East Kingston, NH



The Rockingham County Conservation District applied for a USEPA grant through the New Hampshire Department of Environmental Services (DES) to construct and monitor the effectiveness of a full-scale biofilter septage treatment system at the Bodwell property. Based on favorable test results of the small-scale pilot and an interest in demonstrating constructed wetlands technology, DES helped fund construction of the system at the Bodwell Farm using “319” funds. Section 319 of the Clean Water Act (amended in 1987) established that states, territories, and American Indian tribes receive grant money to support a wide variety of activities including technical assistance, financial assistance, education, training, technology transfer, demonstration projects, and monitoring to assess the success of specific nonpoint source implementation projects.

The resulting biofilter treatment system was constructed during the summer of 1995. Peak flow at the site was expected to be 15,000 gpd (current permitted flow is 10,958 gpd). The facility is comprised of the following components:

- *concrete silo* — 525,000 gal capacity, built by Sollenberger Silos of Pennsylvania
- *pre-treatment chamber* — 24 × 50 × 4 ft, concrete
- *2 wetland cells* — 40 × 270 ft, 30-mil HDPE liner, stone and mulch hay media, vegetated with cattails and reed canary grass
- *unlined receiving meadow and pond* — 44,000 square ft, vegetated with reed canary grass

Septage is treated in a process involving settling and filtering at several stages. Septage is initially discharged to the silo where solids can preferentially settle (solids remaining in the silo are removed every 1–2 years and composted). After discharging from the silo, septage flows through a pre-treatment chamber. The first cells of the chamber allow for additional settling, and the last few are filled with wood chips that assist with filtration. Effluent then flows by a series of gravity feeds through the two constructed wetland areas. When constructed, the first wetland contained cattails planted in a large stone media. The second wetland was divided into three sections separated by hay bales – the first section contained cattails planted in small stone, the second contained cattails planted in a floating mat of mulch hay, and the third contained reed canary grass planted in wood chips. All cattail sections except for the middle section of the second wetland cell have since been replaced by reed canary grass, because the grass is easy to grow and studies have shown that it has a higher nitrogen removal rate (personal communication, Dan Bodwell, January 18, 2001). Free liquid is eventually discharged to the unlined receiving meadow and pond, which were seeded with reed canary grass. Photos showing phases of construction and areas of the finished facility are included in Appendix A.

Costs associated with the biofilter project are shown below in Table 1.

Table 1. 1995 construction costs at the East Kingston Septage Facility

Task	319 Costs	Match Costs	Total Costs
Concrete silo	$59,540	$8,000	$67,540
Pre-treatment cell	$13,566	$3,000	$16,566
Biofilter (wetland) cells (2)	$25,500	$15,000	$40,500
Receiving meadow		$40,890	$40,890
Site preparation		$26,000	$26,000
Hydrogeologic assessment	$10,900		$10,900
Monitoring	$14,700		$14,700
Plumbing materials	$1,000	$1,000	$2,000
Workshops	$3,000	$1,000	$4,000
Total	**$128,206**	**$94,890**	**$223,096**

Water Quality Monitoring Methods

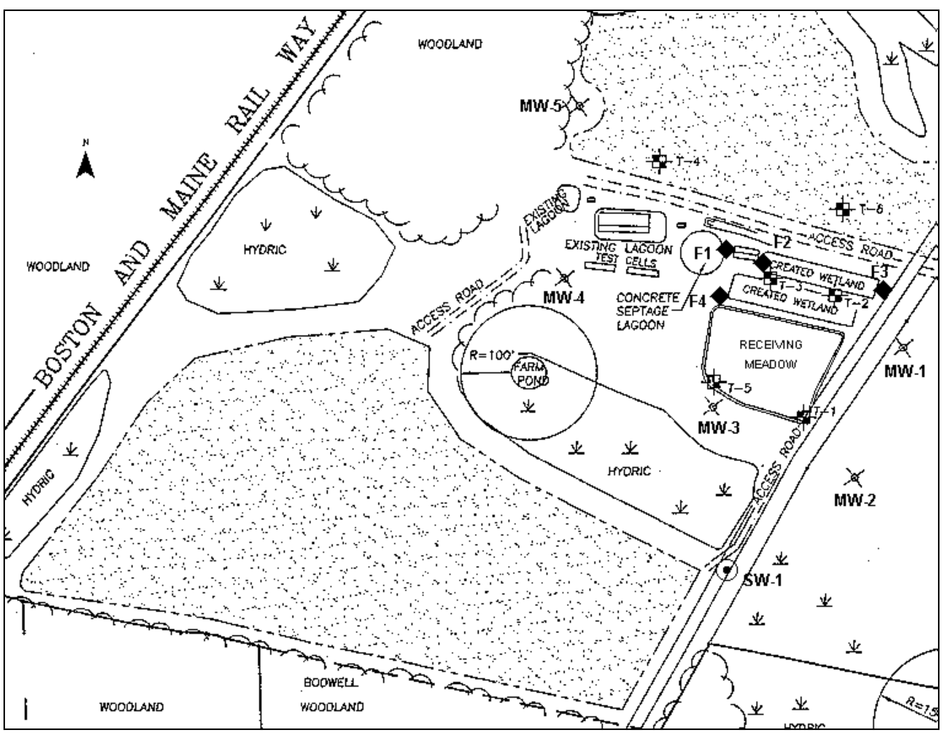
The system was intensively monitored on a quarterly basis for two years after construction. Samples were collected in January, April, June, and October of 1996 and 1997. According to the Quality Assurance Project Plan (QAPP), there were two main purposes to the monitoring plan:

1. To monitor regulated contaminants in groundwater and adjacent surface water as required by NH Code of Administrative Rules, Env-Ws 410, "Groundwater Protection Rules" (in effect at the time), and
2. To measure the pollutant removal capability of the individual components of the system and of the system as a whole.

Groundwater data were obtained from five groundwater wells (MW-1 through MW-5) installed as part of a hydrogeologic study conducted at the site by Nobis Engineering (1994)[1]. The wells were established prior to the construction of the biotreatment facility and are located as follows (see Figure 2):

MW-1 – Side-gradient of the constructed wetlands
MW-2 – Side-gradient/downgradient of receiving meadow
MW-3 – Downgradient of unlined receiving meadow
MW-4 – Downgradient of pre-existing lagoon
MW-5 – Upgradient of facility

Figure 2. Bodwell facility site plan in East Kingston, NH



[1] Nobis Engineering, Inc. 1994. Hydrogeologic Investigation, East Kingston Septage Facility, Route 108 and Sanborn Road, East Kingston, New Hampshire (File No. 48920). Concord, NH.

One off-site surface water sampling location, SW-1, was also established during the hydrogeologic study. The site is located east of the farm access road in a culvert that crosses the native wetland south of the facility.

To measure the pollutant removal capability of the treatment system, effluent was sampled at four locations throughout the system, as follows:

F1 – pre-treatment cell influent (measures silo effluent)
F2 – pre-treatment cell effluent
F3 – wetlands cell 1 effluent
F4 – wetlands cell 2 effluent (effluent from F4 was predicted to be "clean" water discharge)

Water samples were analyzed for pH, specific conductivity, volatile organic compounds (VOCs), nitrate + nitrite, total Kjeldahl nitrogen (TKN), and the following metals: arsenic, barium, cadmium, total chromium, copper, lead, mercury, nickel, selenium, silver, and zinc. Effluent samples analyzed for metals could not be filtered in the field using disposable 0.45-µm syringe filters as planned because particulates clogged the filters. Metals were analyzed in groundwater samples once per year, as required by the groundwater permit; groundwater samples were generally not filtered. Facility effluent samples were also analyzed for total phosphorus (TP), total suspended solids (TSS), *E. coli* bacteria, and five-day biochemical oxygen demand (BOD5). Table 2 displays the sampling schedule for each media.

Table 2. Sampling schedule for East Kingston Septage Facility, 1996 and 1997

Date	F1 through F4	MW1 through MW5	SW1
1/11/96 or 12/6/95 (MWs)	VOCs, metals, TP, TSS, NO_3+NO_2, TKN, NH_3, Cl, *E. coli*, BOD5, pH, conductivity	VOCs, metals, pH, conductivity	TKN, NO_3+NO_2, *E. coli*
4/3/96	VOCs, metals, TP, TSS, NO_3+NO_2, TKN, NH_3, Cl, *E. coli*, BOD5, pH, conductivity	--	Cl
6/19/96	VOCs, metals, TP, TSS, NO_3+NO_2, TKN, NH_3, Cl, *E. coli*, BOD5, pH, conductivity	VOCs, TKN, NO_3+NO_2, Cl	VOCs, TKN, NO_3+NO_2
10/2/96	VOCs, metals, TP, TSS, NO_3+NO_2, TKN, NH_3, Cl, *E. coli*, BOD5	--	--
1/9/97	VOCs, metals, TP, TSS, NO_3+NO_2, TKN, NH_3, Cl, *E. coli*, BOD5	VOCs, metals, TKN, NO_3+NO_2, Cl	VOCs, TKN, NO_3+NO_2, Cl
4/8/97	VOCs, metals, TP, TSS, NO_3+NO_2, TKN, NH_3, Cl, *E. coli*, BOD5	VOCs, metals	--
6/10/97 or 6/24/97 (MWs)	VOCs, metals, TP, TSS, NO_3+NO_2, TKN, NH_3, Cl, *E. coli*, BOD5	VOCs, TKN, NO_3+NO_2, Cl	VOCs TKN, NO_3+NO_2, Cl
10/8/97	VOCs, metals, TP, TSS, NO_3+NO_2, TKN, NH_3, Cl, *E. coli*, BOD5	--	--

Notes:
"--" indicates sample was not collected

Data Summary

This section summarizes the sampling results of effluent, groundwater, and surface water for the two-year period after construction of the septage facility. The complete set of sampling results is included in Appendices B and C.

Effluent

VOCs. Laboratory analysis for approximately 45 VOCs yielded detectable levels of only several compounds. Acetone and toluene were frequently detected in effluent samples, and may be byproducts from the decomposition of organic matter (personal communication, Mike Rainey, DES). Other VOCs that were detected more than once were 1,2-dichlorobenzene; 1,4-dichlorobenzene; and methylethyl ketone (MEK). There were also single detections of carbon disulfide; dimethyl sulfide; m,o,p-xylenes; methylisobutyl ketone (MIBK); tetrachloroethene; trichlorotrifluoroethane; cis-1,2-dichrloroethene; and p-isopropyltoluene. None of the individual concentrations exceeded the NH Surface Water Quality Criteria for Toxic Substances (Table 1703.1 of Env-Ws 1700).

There was a declining trend in total concentrations of VOCs, from 1.43 mg/L in F1 to 0.652 mg/L in F4. This difference was not statistically significant, however, because variation in difference was so high.

Metals. Of the 11 metals analyzed, five metals were significantly reduced in the wetlands system, all at levels greater than 85 percent. Table 3 displays the results. In addition to the metals shown in the table, selenium, mercury, and silver were also analyzed, but these metals were not detected (or else were detected a single time at the detection limit). In the case of mercury, the laboratory detection limit exceeded the NH chronic freshwater criteria and the water and fish ingestion criteria, which makes it impossible to determine whether mercury was present at low levels that are relevant to human and ecological health.

Table 3. Average total metal concentrations in effluent, East Kingston Septage Facility, 1996-1997

Metal	F1	F2	F3	F4	Statistically significant? †	% difference F4 vs. F1 ‡
	(mg/L)					
Arsenic	0.0054	0.0028	0.012	0.0099	No	--
Barium	0.3194	0.2950	0.0276	0.0134	Yes, $p<0.001$	-95.8%
Cadmium	0.0029	0.0024	0.0004	0.0002	Yes, $p<0.001$	-94.9%
Chromium	0.0051	0.007	0.0026	0	No	--
Copper	0.6635	0.6848	0.2381	0.0938	Yes, $p<0.001$	-85.9%
Lead	0.0364	0.0326	0.0126	0.0041	Yes, $p<0.001$	-88.7%
Nickel	0.0179	0.0166	0.0165	0.0104	No	--
Zinc	1.1133	1.1544	0.3654	0.1581	Yes, $p<0.001$	-85.8%

Notes:
Non-detects were assumed to be zero.
† Statistical difference based on paired t-test (dependent samples) between F4 and F1 results, n=8 (7 degrees of freedom).
‡ Percent differences are shown only for those chemicals found to be significantly different.

The average concentrations of several metals at the final effluent point, F4, exceeded NH surface water quality criteria. It is important to note, however, that the surface water criteria apply to state surface waters, and none of the effluent samples were collected from state surface waters. Average copper and zinc concentrations at F4 exceeded the acute freshwater criteria for the protection of aquatic life (0.0036 mg/L and 0.0362 mg/L, respectively, assuming a hardness < 25 mg/L). Average lead concentrations at F4 exceeded the chronic freshwater criteria for the protection of aquatic life (0.00054 mg/L, assuming a hardness < 25 mg/L), and average arsenic concentrations at F4 exceeded the water and fish ingestion criteria for the protection of human health (0.000018 mg/L, based on carcinogenicity). Average metal concentrations at all sites fell below Ambient Groundwater Quality Standards (Table 1500-1 of Env-Ws 1500), except for lead at sites F1 and F2 (the standard for lead is 0.015 mg/L).

<u>Nutrients and chloride</u>. Table 4 shows the average concentrations of nutrients and chloride at each effluent site. TKN and total phosphorus were both significantly reduced. TKN provides a measure of the ammonia and organic nitrogen forms present. Concentrations of nitrate + nitrite, ammonia, and chloride were reduced, but the differences were not significant.

Table 4. Average nutrient and chloride concentrations in effluent, East Kingston Septage Facility, 1996-1997

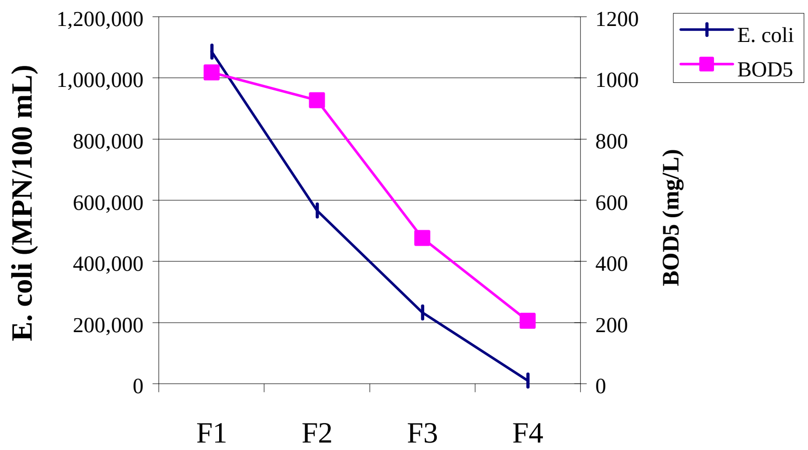
Analyte	F1	F2	F3	F4	Statistically significant? †	% difference F4 vs. F1 ‡
	(mg/L)					
Nitrite + Nitrate	0	0.085	0.0175	0.0263	No	--
TKN	149.2	143.8	117.2	95.08	Yes, p<0.001	-36.3%
Ammonia	95.44	96.87	96.01	78.08	No	--
Total phosphorus	30.37	29.01	21.29	15.03	Yes, p<0.001	-50.5%
Chloride	233.1	219.6	224.4	186.3	No	--

Notes:
Non-detects were assumed to be zero.
† Statistical difference based on paired t-test (dependent samples)between F4 and F1 results, n=8 (7 degrees of freedom).
‡ Percent differences are shown only for those chemicals found to be significantly different.

<u>Biological</u>. Average *E. coli* concentrations were lowered by two orders of magnitude in the constructed wetlands, reduced from 1,085,625 to 10,641 (MPN/100 mL) from influent to effluent. The decrease was not found to be statistically significant, mainly because the variation in the differences between influent and effluent was so high. Despite the substantial decrease, the resulting *E. coli* levels in the effluent exceeded the State of New Hampshire standard of 406/100 mL (for recreational waters that are not designated beaches). Results are shown in Figure 3.

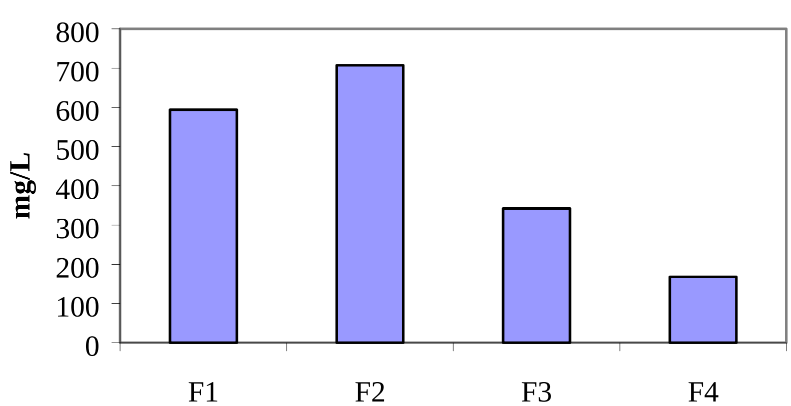
BOD5 concentrations were reduced by 62.8 % from influent to effluent. The decrease was statistically significant (p<0.01). BOD5 measures the oxygen required by microorganisms to oxidize organic carbon to carbon dioxide and water and therefore provides an indirect measure of the quantity of biologically degradable organic matter in water. The BOD5 test can be quite variable. In order to calculate average concentrations, lab results showing concentrations greater than a certain value were assumed to be that value (e.g., >600 was 600). Concentrations less than a certain value were assumed to be zero (e.g., <60 was 0). Although there is no water quality standard for BOD5, typical effluent limits for a secondary wastewater treatment plant are 50 mg/L for a maximum daily limit (personal communication, George Berlandi, DES). Results are shown in Figure 3.

Figure 3. Average concentrations of *E. coli* and BOD5 in effluent by site, East Kingston Septage Facility, 1996-1997



Physical parameters. Total suspended solids (TSS) were reduced by 71% by the wetlands treatment (F1 vs. F4). This difference was statistically significant ($p<0.001$). Although there is no water quality standard for TSS, typical effluent limits for a secondary wastewater treatment plant are 50 mg/L for a maximum daily limit (personal communication, George Berlandi, DES). Results are shown in Figure 4.

Figure 4. Average TSS concentrations in effluent by site, East Kingston Septage Facility, 1996-1997



The pH and conductivity of the surface water sites were measured only during the first three sampling episodes. The pH ranged from 6.4 to 7.3, and conductivity ranged from 750 to 1900 µmhos. There were no apparent trends in either pH or conductivity across sites.

Groundwater

VOCs. MW-4 was the only well with any detectable concentrations of VOCs. In that well, the following compounds were detected on more than one occasion: 1,2-dichlorobenzene; 1,4-dichlorobenzene; and chlorobenzene. MW-4 is located downgradient of the pre-existing lagoon and may reflect an influence of the former lagoon on groundwater. Detections of these compounds were less than the NH Ambient Groundwater Quality Standards (Table 1500-1 of Env-Ws 1500).

Metals. Metals were analyzed on three occasions during the two years after construction. On December 6, 1995, concentrations at MW-4 exceeded the NH Ambient Groundwater Quality Standard (Table 1500-1 of Env-Ws 1500) for arsenic and nickel. Concentrations at all monitoring wells exceeded standards of several metals on January 9, 1997: MW-1 exceeded standards for lead; MW-2 for arsenic, barium, chromium, and nickel; MW-3 for arsenic, lead, chromium, and nickel; and MW-5, the upgradient well, exceeded standards for arsenic, lead, chromium, and nickel on January 9, 1997.

Because of a concern that sampling was introducing particulate matter to groundwater samples, samples collected April 8, 1997 were field filtered. On this date, only nickel concentrations at MW-4 exceeded NH groundwater standards. Groundwater standards are based on dissolved concentrations, therefore samples collected and analyzed on this day may better represent groundwater conditions compared to the standards.

Selenium and silver were not detected in the wells. Mercury was analyzed only once, and it was not detected (detection limit was 0.001 mg/L).

Nutrients and chloride. Nitrate + nitrite and TKN were the only nutrients analyzed in groundwater samples. Table 5 shows the average concentrations for nitrogen and chloride at each site. The drinking water standard for nitrate, 10 mg/L, was exceeded at the upgradient well, MW-5.

Table 5. Average groundwater concentrations of nitrate plus nitrite, TKN, and chloride, East Kingston Septage Facility, 1996-1997

Location	$NO_3 + NO_2$	TKN	Cl
	(mg/L)		
MW-1	8.47	1.08	17. 7
MW-2	4.53	73.5†	8
MW-3	2.34	4.01	83
MW-4	0.093	9.88	137
MW-5	10.15‡	2.03‡	32.5

Notes:
† Questionable result of 219.8 on 1/9/97 (compared to 0.3 the other two times) skews this average high.
‡ Average is based on only two sampling episodes at MW-5.

Surface water

VOCs. VOCs have not been detected at SW-1 to date.

Metals. Metals were not analyzed at SW-1.

Nutrients and chloride. Nitrate + nitrite and TKN were the only nutrients analyzed in surface water samples. The average concentrations for nitrate + nitrite and TKN were 1.01 and 0.447 mg/L, respectively. The average chloride concentration was 31.7 mg/L. These concentrations are well below state standards. Non-detects of nitrogen were assumed to be half the detection limit.

Biological. Bacteria samples were collected at this site only once, in January of 1996. The result was <30 MPN/100 mL. However, because this sample was collected during the winter when bacteria are not very active, no conclusions can be drawn about the impact the treatment facility may be having on bacteria levels in the downgradient wetland.

Conclusions

The biofilter treatment system at Bodwell Farm did result in significant decreases in barium, cadmium, copper, lead, zinc, TKN, total phosphorus, and BOD5 between the influent F1 concentrations and the effluent F4 concentrations. Concentrations of *E. coli* bacteria were also reduced by two orders of magnitude. The resulting average concentrations of several metals and bacteria at F4 were high enough to exceed surface water criteria, but effluent from the facility does not directly discharge to a state surface water source. None of the metal concentrations in effluent exceeded the groundwater standards; in the unlikely event that metals leached into the groundwater, they would not pose an immediate risk. VOCs were occasionally detected at the sites, but not at levels exceeding any standards. Acetone and toluene were the most commonly detected VOCs in the effluent samples, and these may be breakdown products of organic matter. Overall, there was a declining trend of total VOCs from F1 to F4.

In groundwater, the only well with consistent detections of VOCs was MW-4, located downgradient of the former unlined lagoon. Those VOCs detected (1,2-dichlorobenzene; 1,4-dichlorobenzene; and chlorobenzene) were also detected in effluent samples. Groundwater results for metals from the first two sampling episodes could not be compared against the standards because samples were not field-filtered and state groundwater standards are based on dissolved concentrations. Dissolved nickel concentrations during the third sampling round exceeded the NH groundwater standards at MW-4. It is not known if the current or former treatment system influenced groundwater concentrations. Nickel concentrations in the effluent samples were lower than the groundwater samples, however, and nitrate + nitrite concentrations in groundwater were approximately two orders of magnitude higher than in effluent.

The single surface water site, SW-1, was sampled infrequently and not analyzed for the full suite of chemicals. Because of insufficient data, no conclusion can be drawn about the influence at SW-1 from the biofilter system. However, because the treatment effluent drains to a receiving meadow and pond, there are no direct impacts to off-site surface water bodies. During periods of high precipitation or runoff, there may be an influence not likely detected in a quarterly sampling regime.

In general, the results of the monitoring at this site show that using this type of biofilter to treat septic wastes may be a viable alternative to traditional methods. The manager of the facility, Dan Bodwell, has generally been successful getting the system to work, although he recommends finding a better way to remove solids before sending the waste into the system (personal communication, Dan Bodwell, December 5, 2000). Many pollutants found in septic wastes were significantly reduced in the system, and no additional compounds appeared to be generated (ammonia is sometimes a problem in constructed wetlands). For any future biofilter projects that may be located near state surface waters, a more rigorous surface water sampling scheme (including BOD, TSS, and bacteria) would be useful to demonstrate what, if any, influence there is on surface water quality.

Acknowledgments

DES would like to thank Dan Bodwell for his contributions of time, labor, and expertise, and for his willingness to research and experiment with constructed wetland systems and to put his research into practice. DES also thanks Mary Currier, District Manager of the USDA NRCS Rockingham County Conservation District, for making this grant project a reality. Other people who contributed to the field sampling and content of this report are Rob Livingston, Eric Williams, Mitch Locker, and Mike Rainey, all of DES; and Andrea Kenter of GeoInsight, Inc.

Appendix A

Site photos

Pouring concrete onto the base of the silo

Installing silo walls

Laying down liner for wetland cells

Installing wetland vegetation

Pretreatment chambers in foreground; wetland cells in background

View of facility; receiving meadow and pond in background

Appendix B

Facility and surface water data

Biofilter Septage Treatment System
Bodwell Farm, East Kingston, NH

VOCs at facility and surface water sites (ug/L)

SITE	DATE	1,1,1-Trichloroethane	1,1,2,2-Tetrachloroethane	1,1,2--Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	1,2-Dichloroethane
F1	4/3/96	ND	ND	ND	ND	ND	ND	ND	ND	ND
F2	4/3/96	ND	ND	ND	ND	ND	ND	ND	7.9	ND
F3	4/3/96	ND	ND	ND	ND	ND	ND	ND	ND	ND
F4	4/3/96	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRIPb	4/3/96	ND	ND	ND	ND	ND	ND	ND	ND	ND
F1	1/11/96	ND	ND	ND	ND	ND	ND	ND	ND	ND
F2	1/11/96	ND	ND	ND	ND	ND	ND	ND	ND	ND
F3	1/11/96	ND	ND	ND	ND	ND	ND	ND	ND	ND
F4	1/11/96	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRIPb	1/11/96	ND	ND	ND	ND	ND	ND	ND	ND	ND
F1	6/19/96	ND	ND	ND	ND	ND	14	ND	12	ND
F2	6/19/96	ND	ND	ND	ND	ND	6.1	ND	12	ND
F3	6/19/96	ND	ND	ND	ND	ND	8.3	ND	4.8	ND
F4	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRIPb	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND	ND
SW1	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND	ND
F1	10/2/96	ND	ND	ND	ND	ND	ND	ND	ND	ND
F2	10/2/96	ND	ND	ND	ND	ND	ND	ND	ND	ND
F3	10/2/96	ND	ND	ND	ND	ND	ND	ND	ND	ND
F4	10/2/96	ND	ND	ND	ND	ND	ND	ND	ND	ND
F1	1/9/97	ND	ND	ND	ND	ND	15	ND	18	ND
F2	1/9/97	ND	ND	ND	ND	ND	16	ND	18	ND
F4	1/9/97	ND	ND	ND	ND	ND	ND	ND	ND	ND
F3	1/9/97	ND	ND	ND	ND	ND	ND	ND	ND	ND
SW 1	1/9/97	ND	ND	ND	ND	ND	ND	ND	ND	ND
F1	4/8/97	ND	ND	ND	ND	ND	ND	ND	ND	ND
F2	4/8/97	ND	ND	ND	ND	ND	ND	ND	ND	ND
F3	4/8/97	ND	ND	ND	ND	ND	ND	ND	ND	ND
F4	4/8/97	ND	ND	ND	ND	ND	ND	ND	ND	ND
SW 1	6/10/97	ND	ND	ND	ND	ND	ND	ND	ND	ND
F1	6/10/97	ND	ND	ND	ND	ND	11	ND	14	ND
F2	6/10/97	ND	ND	ND	ND	ND	10	ND	13	ND
F3	6/10/97	ND	ND	ND	ND	ND	ND	ND	ND	ND
F4	6/10/97	ND	ND	ND	ND	ND	ND	ND	ND	ND
F1	10/8/97	ND	ND	ND	ND	ND	21	ND	25	ND
F2	10/8/97	ND	ND	ND	ND	ND	ND	ND	ND	ND
F3	10/8/97	ND	ND	ND	ND	ND	ND	ND	ND	ND
F4	10/8/97	ND	ND	ND	ND	ND	ND	ND	ND	ND
F5	10/8/97	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes:
ND = not detected

Biofilter Septage Treatment System
Bodwell Farm, East Kingston, NH

VOCs at facility and surface water sites (ug/L)

SITE	DATE	1,2-Dichloropropane	2-Chloroethylvinyl ether	Acetone	Benzene	Bromoform	Bromomethane	Carbon disulfide	Carbon tetrachloride	Chlorobenzene	Chloroethane	Chloroform	Chloromethane
F1	4/3/96	ND	ND	96	ND	ND	ND	ND	ND	ND	ND	ND	ND
F2	4/3/96	ND	ND	150	ND	ND	ND	5.5	ND	ND	ND	ND	ND
F3	4/3/96	ND	ND	110	ND	ND	ND	ND	ND	ND	ND	ND	ND
F4	4/3/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRIPb	4/3/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
F1	1/11/96	ND	ND	420	ND	ND	ND	ND	ND	ND	ND	ND	ND
F2	1/11/96	ND	ND	220	ND	ND	ND	ND	ND	ND	ND	ND	ND
F3	1/11/96	ND	ND	220	ND	ND	ND	ND	ND	ND	ND	ND	ND
F4	1/11/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRIPb	1/11/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	15	ND
F1	6/19/96	ND	ND	200	ND	ND	ND	ND	ND	ND	ND	ND	ND
F2	6/19/96	ND	ND	280	ND	ND	ND	ND	ND	ND	ND	ND	ND
F3	6/19/96	ND	ND	180	ND	ND	ND	ND	ND	ND	ND	ND	ND
F4	6/19/96	ND	ND	160	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRIPb	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SW1	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
F1	10/2/96	ND	ND	320	ND	ND	ND	ND	ND	ND	ND	ND	ND
F2	10/2/96	ND	ND	330	ND	ND	ND	ND	ND	ND	ND	ND	ND
F3	10/2/96	ND	ND	220	ND	ND	ND	ND	ND	ND	ND	ND	ND
F4	10/2/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
F1	1/9/97	ND	ND	170	ND	ND	ND	ND	ND	ND	ND	ND	ND
F2	1/9/97	ND	ND	170	ND	ND	ND	ND	ND	ND	ND	ND	ND
F4	1/9/97	ND	ND	130	ND	ND	ND	ND	ND	ND	ND	ND	ND
F3	1/9/97	ND	ND	170	ND	ND	ND	ND	ND	ND	ND	ND	ND
SW 1	1/9/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
F1	4/8/97	ND	ND	230	ND	ND	ND	ND	ND	ND	ND	ND	ND
F2	4/8/97	ND	ND	230	ND	ND	ND	ND	ND	ND	ND	ND	ND
F3	4/8/97	ND	ND	400	ND	ND	ND	ND	ND	ND	ND	ND	ND
F4	4/8/97	ND	ND	160	ND	ND	ND	ND	ND	ND	ND	ND	ND
SW 1	6/10/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
F1	6/10/97	ND	ND	400	ND	ND	ND	ND	ND	ND	ND	ND	ND
F2	6/10/97	ND	ND	350	ND	ND	ND	ND	ND	ND	ND	ND	ND
F3	6/10/97	ND	ND	200	ND	ND	ND	ND	ND	ND	ND	ND	ND
F4	6/10/97	ND	ND	98	ND	ND	ND	ND	ND	ND	ND	ND	ND
F1	10/8/97	ND	ND	280	ND	ND	ND	ND	ND	ND	ND	ND	ND
F2	10/8/97	ND	ND	200	ND	ND	ND	ND	ND	ND	ND	ND	ND
F3	10/8/97	ND	ND	140	ND	ND	ND	ND	ND	ND	ND	ND	ND
F4	10/8/97	ND	ND	58	ND	ND	ND	ND	ND	ND	ND	ND	ND
F5	10/8/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	14	ND

Notes:
ND = not detected

Biofilter Septage Treatment System
Bodwell Farm, East Kingston, NH

VOCs at facility and surface water sites (ug/L)

SITE	DATE	cis-1,3-Dichloropropene	Cyclohexane	Dibromochloromethane	Dichlorobromomethane	Diethyl ether	Dimethyl disulfide	Dimethyl sulfide	Ethylbenzene	m/p-Xylenes	Methyl ethyl ketone	Methyl-t-butyl ether (MBTE)	Methylene chloride
F1	4/3/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
F2	4/3/96	ND	ND	ND	ND	ND	ND	ND	ND	4.4	36	ND	ND
F3	4/3/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	22	ND	ND
F4	4/3/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRIPb	4/3/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
F1	1/11/96	ND	ND	ND	ND	ND	ND	24	ND	ND	ND	ND	ND
F2	1/11/96	ND	ND	ND	ND	ND	ND	25	ND	ND	ND	ND	ND
F3	1/11/96	ND	ND	ND	ND	ND	ND	25	ND	ND	ND	ND	ND
F4	1/11/96	ND	ND	ND	ND	ND	ND	47	ND	ND	ND	ND	ND
TRIPb	1/11/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
F1	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	61	ND	ND
F2	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	73	ND	ND
F3	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	45	ND	ND
F4	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	60	ND	ND
TRIPb	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SW1	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
F1	10/2/96	ND	ND	ND	ND	ND	ND	ND	ND	50	250	ND	ND
F2	10/2/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
F3	10/2/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
F4	10/2/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
F1	1/9/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
F2	1/9/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
F4	1/9/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
F3	1/9/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SW 1	1/9/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
F1	4/8/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
F2	4/8/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
F3	4/8/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
F4	4/8/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SW 1	6/10/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
F1	6/10/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	76	ND	ND
F2	6/10/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
F3	6/10/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
F4	6/10/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
F1	10/8/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
F2	10/8/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
F3	10/8/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
F4	10/8/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
F5	10/8/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes:
ND = not detected

Biofilter Septage Treatment System
Bodwell Farm, East Kingston, NH

VOCs at facility and surface water sites (ug/L)

SITE	DATE	Methyl isobutyl ketone	o-Xylenes	Styrene	Tetrachloroethene	THF	Toluene	trans-1,2-Dichloroethene	trans-1,3-Dichloropropene	Trichloroethene	Trichlorofluoromethane	Trichlorotrifluoroethane	Vinyl acetate	Vinyl chloride
F1	4/3/96	ND	ND	ND	ND	ND	370	ND	ND	ND	ND	ND	ND	ND
F2	4/3/96	ND	3.5	ND	4.4	ND	260	ND	ND	ND	ND	ND	ND	ND
F3	4/3/96	ND	ND	ND	4.6	ND	190	ND	ND	ND	ND	ND	ND	ND
F4	4/3/96	ND	ND	ND	ND	ND	390	ND	ND	ND	ND	ND	ND	ND
TRIPb	4/3/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
F1	1/11/96	ND	ND	ND	ND	ND	420	ND	ND	ND	ND	ND	ND	ND
F2	1/11/96	ND	ND	ND	ND	ND	420	ND	ND	ND	ND	ND	ND	ND
F3	1/11/96	ND	ND	ND	ND	ND	220	ND	ND	ND	ND	ND	ND	ND
F4	1/11/96	ND	ND	ND	ND	ND	990	ND	ND	ND	ND	ND	ND	ND
TRIPb	1/11/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
F1	6/19/96	ND	ND	ND	ND	ND	420	ND	ND	ND	ND	ND	ND	ND
F2	6/19/96	ND	ND	ND	ND	ND	2000	ND	ND	ND	ND	ND	ND	ND
F3	6/19/96	ND	ND	ND	ND	ND	1500	ND	ND	ND	ND	ND	ND	ND
F4	6/19/96	ND	ND	ND	ND	ND	1900	ND	ND	ND	ND	ND	ND	ND
TRIPb	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SW1	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
F1	10/2/96	ND	ND	ND	ND	ND	3100	ND	ND	ND	ND	ND	ND	ND
F2	10/2/96	ND	ND	ND	ND	ND	3100	ND	ND	ND	ND	ND	ND	ND
F3	10/2/96	ND	ND	ND	ND	ND	2000	ND	ND	ND	ND	ND	ND	ND
F4	10/2/96	ND	ND	ND	ND	ND	410	ND	ND	ND	ND	ND	ND	ND
F1	1/9/97	ND	ND	ND	ND	ND	910	ND	ND	ND	ND	ND	ND	ND
F2	1/9/97	ND	ND	ND	ND	ND	910	ND	ND	ND	ND	ND	ND	ND
F4	1/9/97	ND	ND	ND	ND	ND	340	ND	ND	ND	ND	ND	ND	ND
F3	1/9/97	ND	ND	ND	ND	ND	650	ND	ND	ND	ND	ND	ND	ND
SW 1	1/9/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
F1	4/8/97	ND	ND	ND	ND	ND	830	ND	ND	ND	ND	ND	ND	ND
F2	4/8/97	ND	ND	ND	ND	ND	570	ND	ND	ND	ND	ND	ND	ND
F3	4/8/97	ND	ND	ND	ND	ND	450	ND	ND	ND	ND	ND	ND	ND
F4	4/8/97	ND	ND	ND	ND	ND	460	ND	ND	ND	ND	ND	ND	ND
SW 1	6/10/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
F1	6/10/97	ND	ND	ND	ND	ND	1000	ND	ND	ND	ND	12	ND	ND
F2	6/10/97	70	ND	ND	ND	ND	680	ND	ND	ND	ND	ND	ND	ND
F3	6/10/97	ND	ND	ND	ND	ND	200	ND	ND	ND	ND	ND	ND	ND
F4	6/10/97	ND	ND	ND	ND	ND	130	ND	ND	ND	ND	ND	ND	ND
F1	10/8/97	ND	ND	ND	ND	ND	1600	ND	ND	ND	ND	ND	ND	ND
F2	10/8/97	ND	ND	ND	ND	ND	1100	ND	ND	ND	ND	ND	ND	ND
F3	10/8/97	ND	ND	ND	ND	ND	460	ND	ND	ND	ND	ND	ND	ND
F4	10/8/97	ND	ND	ND	ND	ND	83	ND	ND	ND	ND	ND	ND	ND
F5	10/8/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes:
ND = not detected

Biofilter Septage Treatment System
Bodwell Farm, East Kingston, NH

VOCs at facility and surface water sites (ug/L)

SITE	DATE	VOC47	Hexanone	cis-1,2-Dichloroethene	p-Isopropyltoluene
F1	4/3/96	ND	ND	ND	ND
F2	4/3/96	ND	ND	ND	ND
F3	4/3/96	ND	ND	ND	ND
F4	4/3/96	ND	ND	ND	ND
TRIPb	4/3/96	ND	ND	ND	ND
F1	1/11/96	ND	ND	ND	ND
F2	1/11/96	ND	ND	ND	ND
F3	1/11/96	ND	ND	ND	ND
F4	1/11/96	ND	ND	ND	ND
TRIPb	1/11/96	ND	ND	ND	ND
F1	6/19/96	ND	ND	ND	ND
F2	6/19/96	ND	ND	ND	ND
F3	6/19/96	ND	ND	ND	ND
F4	6/19/96	ND	ND	ND	ND
TRIPb	6/19/96	ND	ND	ND	ND
SW1	6/19/96	ND	ND	ND	ND
F1	10/2/96	ND	ND	ND	ND
F2	10/2/96	ND	ND	ND	ND
F3	10/2/96	ND	ND	ND	ND
F4	10/2/96	ND	ND	ND	ND
F1	1/9/97	ND	ND	ND	ND
F2	1/9/97	ND	ND	ND	ND
F4	1/9/97	ND	ND	ND	ND
F3	1/9/97	ND	ND	ND	ND
SW 1	1/9/97	ND	ND	ND	ND
F1	4/8/97	ND	ND	ND	ND
F2	4/8/97	ND	ND	ND	ND
F3	4/8/97	ND	ND	ND	ND
F4	4/8/97	ND	ND	ND	ND
SW 1	6/10/97	ND	ND	ND	ND
F1	6/10/97	ND	ND	ND	ND
F2	6/10/97	ND	ND	ND	ND
F3	6/10/97	ND	ND	ND	ND
F4	6/10/97	ND	ND	ND	ND
F1	10/8/97	ND	ND	23	55
F2	10/8/97	ND	ND	22	55
F3	10/8/97	ND	ND	11	24
F4	10/8/97	ND	ND	ND	20
F5	10/8/97	ND	ND	ND	ND

Notes:
ND = not detected

Biofilter Septage Treatment System
Bodwell Farm, East Kingston, NH

Metals at facility and surface water sites (mg/L)

Site	Date	As	Cd	Pb	Se	Hg	Ba	Cr	Cu	Ni	Ag	Zn
F1	1/11/96	<.01	0.001	<.02	<.05	<.001	0.115	<.01	0.299	<.02	<.01	0.506
F2	1/11/96	<.01	0.001	<.02	<.05	<.001	0.106	<.01	0.32	<.02	<.01	0.574
F3	1/11/96	0.016	<.001	<.02	<.05	<.001	<.1	<.01	0.211	0.02	<.01	0.299
F4	1/11/96	<.01	<.001	<.02	<.05	<.001	0.107	<.01	0.151	<.02	<.01	0.21
F1	4/3/96	<.005	0.002	0.016	<.010	<.001	0.168	<.005	0.42	0.015	<.005	0.755
F2	4/3/96	<.005	0.002	0.018	<.010	<.001	0.185	<.005	0.409	0.015	<.005	0.668
F3	4/3/96	0.006	<.001	0.006	<.010	<.001	0.073	<.005	0.14	0.022	<.005	0.24
F4	4/3/96	0.006	<.001	<.005	<.01	<.001	<.05	<.005	<.025	0.011	<.005	0.04
F1	6/19/96	0.007	0.002	0.043	<.01	<.001	0.242	<.01	0.386	<.02	<.01	0.743
F2	6/19/96	<.005	<.001	0.019	<.01	<.001	0.126	<.01	0.193	<.02	<.01	0.324
F3	6/19/96	0.026	<.001	0.011	<.01	<.001	<.1	<.01	0.054	<.02	<.01	0.089
F4	6/19/96	0.03	<.001	<.005	<.01	<.001	<.1	<.01	<.05	<.02	<.01	0.066
F1	10/2/96	0.007	0.002	0.043	<.01	<.001	0.505	0.015	1.12	0.027	<.01	2.04
F2	10/2/96	<.005	<.001	0.019	<.01	<.001	0.459	0.018	1.06	0.032	<.01	1.96
F3	10/2/96	0.026	<.001	0.011	<.01	<.001	<.1	<.01	0.299	0.015	<.01	0.493
F4	10/2/96	0.03	<.001	<.005	<.01	<.001	<.1	<.01	<.05	<.02	<.01	0.061
F1	1/9/97	<.005	0.0056	0.041	<.010	--	0.366	<.01	0.696	0.026	<.01	1.14
F2	1/9/97	<.005	0.0035	0.031	<.010	--	0.15	<.01	0.546	0.021	<.01	0.872
F4	1/9/97	<.005	<.001	0.006	<.010	--	<.1	<.01	0.076	<.02	<.01	0.1
F3	1/9/97	<.005	0.0012	0.009	<.010	--	<.1	<.01	0.292	0.024	<.01	0.448
F1	4/8/97	0.02	0.003	0.032	<.010	--	0.358	<.01	0.727	0.024	<.01	0.872
F2	4/8/97	<.005	0.002	0.023	<.010	--	0.201	<.01	0.61	<.02	<.01	0.867
F3	4/8/97	0.01	<.001	0.02	<.010	--	<.1	0.011	0.256	0.022	<.01	0.31
F4	4/8/97	0.005	<.001	0.005	<.010	--	<.1	<.01	0.066	<.02	<.01	0.087
F1	6/10/97	0.009	0.0043	0.06	<.010	--	0.432	0.014	0.865	0.027	<.01	1.46
F2	6/10/97	0.01	0.0045	0.046	<.010	--	0.344	0.011	0.94	0.03	<.01	1.52
F3	6/10/97	0.012	0.0018	0.029	<.010	--	0.148	0.01	0.528	0.025	<.01	0.822
F4	6/10/97	0.008	<.001	0.009	<.010	--	<.1	<.01	0.123	0.023	<.01	0.188
F1	10/8/97	<.010	0.0036	0.056	<.020	<.001	0.369	0.012	0.795	0.024	<.01	1.39
F2	10/8/97	0.012	0.006	0.105	<.020	0.001	0.789	0.027	1.4	0.035	0.01	2.45
F3	10/8/97	<.010	0.0015	0.018	<.020	<.001	<.1	<.01	0.341	0.028	<.01	0.57
F4	10/8/97	<.010	<.001	0.01	<.020	<.001	<.1	<.01	0.118	0.025	<.01	0.165

Biofilter Septage Treatment System
Bodwell Farm, East Kingston, NH

Nitrogen compounds at facility and surface water sites (mg/L)

	F1			F2			F3			F4		
date	**NO_3+NO_2**	**TKN**	**NH_3**	**NO_3+NO_2**	**TKN**	**NH_3**	**NO_3+NO_2**	**TKN**	**NH_3**	**NO_3+NO_2**	**TKN**	**NH_3**
1/11/96	<.1	113.5	76.99	<.01	110.9	80.38	<.1	102	79.6	<.01	96.6	76.05
4/3/96	<.05	113.1	73.9	<.05	92.4	73.4	<.05	68.4	62.5	<.05	24.3	25.2
6/19/96	<.05	119.2	86	<.05	101.9	85	<.05	89	82	<.05	80.2	71
10/2/96	<.05	190	110	<.05	179	112	<.05	145	124	<.05	98.5	113
1/9/97	<.05	155	89	0.06	147	96.8	<.05	123	89	0.05	76	58.8
4/8/97	<.05	137	109	0.05	150	109	0.07	106	105	0.05	119	68
6/10/97	<0.05	196	124	<0.05	189	124	0.07	164	127	0.04	146	117
10/8/97	<0.05	170	94.6	0.57	180	94.4	<0.05	140	99	0.07	120	95.6

	SW1		
date	**NO_3+NO_2**	**TKN**	**NH_3**
1/11/96	2.1	0.32	NS
4/3/96			
6/19/96	<0.05	0.46	NS
10/2/96			
1/9/97	1.9	<0.5	NS
4/8/97			
6/10/97	<0.05	0.56	NS
10/8/97			

Biofilter Septage Treatment System
Bodwell Farm, East Kingston, NH

TP, TSS, and Cl at facility and surface water sites (mg/L)

	Total Phosphorus				Total Suspended Solids				Chloride				
date	**F1**	**F2**	**F3**	**F4**	**F1**	**F2**	**F3**	**F4**	**F1**	**F2**	**F3**	**F4**	**SW1**
1/11/96	19.21	18.75	16.16	11.92	200	410	300	280	209	210	205	211	
4/3/96	22.6	21.2	12.1	4.43	445	410	210	32	194	170	150	60	
6/19/96	28.7	25.8	14.9	10.7	613	334	300	155	220	231	254		40
10/2/96	35.1	33.7	25.5	18.95	155	1250	500	156	217	191	186	164	
1/9/97	33.4	26.6	20.3	12.9	667	466	280	85	200	210	210	170	48
4/8/97	30	30	24	15	875	650	340	260	235	220	215	139	
6/10/97	38.75	34.25	27.95	25.5	970	913	440	181	360	275	340	280	37
10/8/97	35.2	41.8	29.4	20.8	825	1225	370	195	230	250	235	280	

Biofilter Septage Treatment System
Bodwell Farm, East Kingston, NH

E. coli and BOD5 at facility and surface water sites

	E. Coli (MPN/100 mL)					BOD5 (mg/L)			
date	**F1**	**F2**	**F3**	**F4**	**SW1**	**F1**	**F2**	**F3**	**F4**
1/11/96	240,000	140,000	93,000	9,300	<30	525	505	445	575
4/3/96	930,000	430,000	93,000	230		660	720	420	162
6/19/96	35,000	6,100	8,400	1,600		>800	>800	350	330
10/2/96	240,000	430,000	24,000	9,300		>880	444	220	78
1/9/97	4,300,000	2,400,000	930,000	15,000		600-900	> 600	445	<60
4/8/97	390,000	240,000	430,000	4,300		1410	1080	810	300
6/10/97	2,400,000	430,000	240,000	2,400		2130	1830	460	< 200
10/8/97	150,000	460,000	43,000	43,000		990	1440	660	200

Biofilter Septage Treatment System
Bodwell Farm, East Kingston, NH

pH and Conductivity at facility sites

	pH				Conductivity (umhos)			
date	**F1**	**F2**	**F3**	**F4**	**F1**	**F2**	**F3**	**F4**
1/11/96	7.3	6.65	6.65	6.6	940	810	805	750
4/3/96	6.7	6.8	7.1	6.6	465	1180	1300	1390
6/19/96	5.8	6	7.1	6.4	1700	1895	1900	1750
10/2/96								
1/9/97								
4/8/97								
6/10/97								
10/8/97								

Appendix C
Groundwater data

Biofilter Septage Treatment System
Bodwell Farm, East Kingston, NH

VOCs in groundwater (ug/L)

SITE	DATE	1,1,1-Trichloroethane	1,1,2,2-Tetrachloroethane	1,1,2--Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene
MW1	12/6/95	ND	ND	ND	ND	ND	ND	ND	ND
MW2	12/6/95	ND	ND	ND	ND	ND	ND	ND	ND
MW3	12/6/95	ND	ND	ND	ND	ND	ND	ND	ND
MW4	12/6/95	ND	ND	ND	2.2	ND	2.7	ND	8.6
MW5	12/6/95	ND	ND	ND	ND	ND	ND	ND	ND
TRIPb	12/6/95	ND	ND	ND	ND	ND	ND	ND	ND
TRIPb	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND
MW1	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND
MW2	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND
MW3	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND
MW4	6/19/96	ND	ND	ND	ND	ND	2.3	ND	8.1
MW5	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND
MW1	1/9/97	ND	ND	ND	ND	ND	ND	ND	ND
MW 2	1/9/97	ND	ND	ND	ND	ND	ND	ND	ND
MW 3	1/9/97	ND	ND	ND	ND	ND	ND	ND	ND
MW 4	1/9/97	ND	ND	ND	ND	ND	2.1	ND	7.5
MW 5	1/9/97	ND	ND	ND	ND	ND	ND	ND	ND
MW 1	4/8/97								
MW 2	4/8/97	VOCs not analyzed on this date							
MW 3	4/8/97								
MW 4	4/8/97								
MW 5	4/8/97								
MW 1	6/24/97	ND	ND	ND	ND	ND	ND	ND	ND
MW 2	6/24/97	ND	ND	ND	ND	ND	ND	ND	ND
MW3	6/24/97	ND	ND	ND	ND	ND	ND	ND	ND
MW 4	6/24/97	ND	ND	ND	ND	ND	2	ND	8.4
TRIPb	6/24/97	ND	ND	ND	ND	ND	ND	ND	ND

Notes:
ND = not detected

Biofilter Septage Treatment System
Bodwell Farm, East Kingston, NH

VOCs in groundwater (ug/L)

SITE	DATE	1,2-Dichloroethane	1,2-Dichloropropane	2-Chloroethylvinyl ether	Acetone	Benzene	Bromoform	Bromomethane	Carbon disulfide	Carbon tetrachloride	Chlorobenzene	Chloroethane
MW1	12/6/95	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW2	12/6/95	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW3	12/6/95	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW4	12/6/95	ND	ND	ND	ND	ND	ND	ND	ND	ND	8.1	ND
MW5	12/6/95	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRIPb	12/6/95	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRIPb	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW1	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW2	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW3	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW4	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	9.1	ND
MW5	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW1	1/9/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW 2	1/9/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW 3	1/9/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW 4	1/9/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	9.3	ND
MW 5	1/9/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW 1	4/8/97											
MW 2	4/8/97											
MW 3	4/8/97											
MW 4	4/8/97											
MW 5	4/8/97											
MW 1	6/24/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW 2	6/24/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW3	6/24/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW 4	6/24/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	8.5	ND
TRIPb	6/24/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes:
ND = not detected

Biofilter Septage Treatment System
Bodwell Farm, East Kingston, NH

VOCs in groundwater (ug/L)

SITE	DATE	Chloroform	Chloromethane	cis-1,3-Dichloropropene	Cyclohexane	Dibromochloromethane	Dichlorobromomethane	Diethyl ether	Dimethyl disulfide	Dimethyl sulfide	Ethylbenzene	m/p-Xylenes
MW1	12/6/95	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW2	12/6/95	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW3	12/6/95	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW4	12/6/95	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW5	12/6/95	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRIPb	12/6/95	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRIPb	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW1	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW2	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW3	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW4	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW5	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW1	1/9/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW 2	1/9/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW 3	1/9/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW 4	1/9/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW 5	1/9/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW 1	4/8/97											
MW 2	4/8/97											
MW 3	4/8/97											
MW 4	4/8/97											
MW 5	4/8/97											
MW 1	6/24/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW 2	6/24/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW3	6/24/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW 4	6/24/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRIPb	6/24/97	5.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes:
ND = not detected

Biofilter Septage Treatment System
Bodwell Farm, East Kingston, NH

VOCs in groundwater (ug/L)

SITE	DATE	Methyl ethyl ketone	Methyl-t-butyl ether (MBTE)	Methylene chloride	Methyl isobutyl ketone	o-Xylenes	Styrene	Tetrachloroethene	THF	Toluene	trans-1,2-Dichloroethene	trans-1,3-Dichloropropene	Trichloroethene
MW1	12/6/95	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW2	12/6/95	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW3	12/6/95	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW4	12/6/95	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW5	12/6/95	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRIPb	12/6/95	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRIPb	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW1	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW2	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW3	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW4	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW5	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW1	1/9/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW 2	1/9/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW 3	1/9/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW 4	1/9/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW 5	1/9/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW 1	4/8/97												
MW 2	4/8/97												
MW 3	4/8/97												
MW 4	4/8/97												
MW 5	4/8/97												
MW 1	6/24/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW 2	6/24/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW3	6/24/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW 4	6/24/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRIPb	6/24/97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes:
ND = not detected

Biofilter Septage Treatment System
Bodwell Farm, East Kingston, NH

VOCs in groundwater (ug/L)

SITE	DATE	Trichlorofluoromethane	Trichlorotrifluoroethane	Vinyl acetate	Vinyl chloride	VOC47	Hexanone	cis-1,2-Dichloroethene	p-Isopropyltoluene	o-chlorotoluene
MW1	12/6/95	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW2	12/6/95	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW3	12/6/95	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW4	12/6/95	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW5	12/6/95	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRIPb	12/6/95	ND	ND	ND	ND	ND	ND	ND	ND	ND
TRIPb	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW1	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW2	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW3	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW4	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW5	6/19/96	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW1	1/9/97	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW 2	1/9/97	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW 3	1/9/97	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW 4	1/9/97	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW 5	1/9/97	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW 1	4/8/97									
MW 2	4/8/97									
MW 3	4/8/97									
MW 4	4/8/97									
MW 5	4/8/97									
MW 1	6/24/97	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW 2	6/24/97	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW3	6/24/97	ND	ND	ND	ND	ND	ND	ND	ND	ND
MW 4	6/24/97	ND	ND	ND	ND	ND	ND	ND		2.6
TRIPb	6/24/97	ND	ND	ND	ND	ND	ND	ND	ND	ND

Notes:
ND = not detected

Biofilter Septage Treatment System
Bodwell Farm, East Kingston, NH

Metals in groundwater (mg/L)

Site	Date	As	Cd	Pb	Se	Hg	Ba	Cr	Cu	Ni	Ag	Zn
MW1	12/6/95	<0.005	<0.001	<0.005	<0.010	<0.001	<0.1	<0.01	<0.05	<0.02	<0.01	0.091
MW2	12/6/95	0.006	<0.001	<0.005	<0.010	<0.001	<0.1	<0.01	<0.05	<0.02	<0.01	<0.05
MW3	12/6/95	0.02	<0.001	<0.005	<0.010	<0.001	<0.1	<0.01	<0.05	<0.02	<0.01	<0.05
MW4	12/6/95	0.24	<0.001	<0.005	<0.010	<0.001	0.145	<0.01	<0.05	0.458	<0.01	<0.05
MW5	12/6/95	<0.005	<0.001	<0.005	<0.010	<0.001	0.113	<0.01	<0.05	<0.02	<0.01	<0.05
MW1	1/9/97	0.02	<0.001	0.017	<0.050	NS	0.434	0.14	0.056	0.088	<0.01	0.11
MW2	1/9/97	1.02	0.002	0.04	<0.050	NS	2.16	0.891	0.586	0.655	<0.01	0.731
MW3	1/9/97	0.85	0.0012	0.019	<0.010	NS	0.484	0.201	0.165	0.231	<0.01	0.283
MW4	1/9/97	0.158	0.0036	0.013	<0.010	NS	0.092	0.014	0.055	0.137	<0.01	<0.05
MW5	1/9/97	0.203	0.0012	0.064	<0.010	NS	0.525	0.338	0.21	0.298	<0.01	0.328
MW1-F	4/8/97	<0.005	<0.001	<0.005	<0.010	NS	<0.1	<0.01	<0.05	<0.02	<0.01	<0.05
MW2-F	4/8/97	<0.005	<0.001	<0.005	<0.010	NS	<0.1	<0.01	<0.05	<0.02	<0.01	<0.05
MW3-F	4/8/97	<0.005	<0.001	<0.005	<0.010	NS	<0.1	<0.01	<0.05	<0.02	<0.01	0.119
MW4-F	4/8/97	<0.005	0.001	<0.005	<0.010	NS	<0.1	<0.01	<0.05	0.148	<0.01	0.271
MW5-F	4/8/97	<0.005	<0.001	<0.005	<0.010	NS	<0.1	<0.01	<0.05	<0.02	<0.01	<0.05

Notes:
Samples collected on 4/8/97 were filtered.

Biofilter Septage Treatment System
Bodwell Farm, East Kingston, NH

Nitrogen compounds in groundwater (mg/L)

	MW1			MW2			MW3			MW4			MW5		
date	**NO_3+NO_2**	**TKN**	**NH_3**	**NO_3+NO_2**	**TKN**	**NH_3**	**NO_3+NO_2**	**TKN**	**NH_3**	**NO_3+NO_2**	**TKN**	**NH_3**	**NO_3+NO_2**	**TKN**	**NH_3**
6/19/96	11.4	0.84	NS	5.74	0.3	NS	0.42	1.02	NS	0.06	6.44	NS	10.4	2.36	NS
1/9/97	7.8	1.4	NS	2.36	219.8	NS	3.52	10.4	NS	0.16	15.7	NS	9.9	1.7	NS
6/24/97	6.2	1	NS	5.48	0.3	NS	3.08	0.6	NS	0.06	7.5	NS			

Biofilter Septage Treatment System
Bodwell Farm, East Kingston, NH

Chloride in groundwater (mg/L)

date	MW1	MW2	MW3	MW4	MW5
6/19/96	15	10	77	191	42
1/9/97	21	5	96	120	23
6/24/97	17	9	76	100	